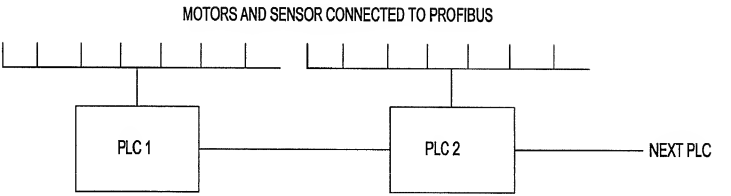


FIG. 1

(PRIOR ART)

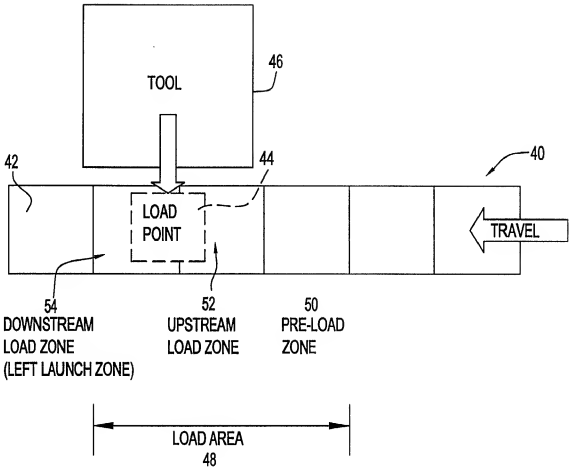

TOOL
46
42
44
40
LOAD
POINT
TRAVEL
54
DOWNSTREAM
LOAD ZONE
(LEFT LAUNCH ZONE)
52
UPSTREAM
LOAD ZONE
50
PRE-LOAD
ZONE
LOAD AREA
48

FIG. 2A

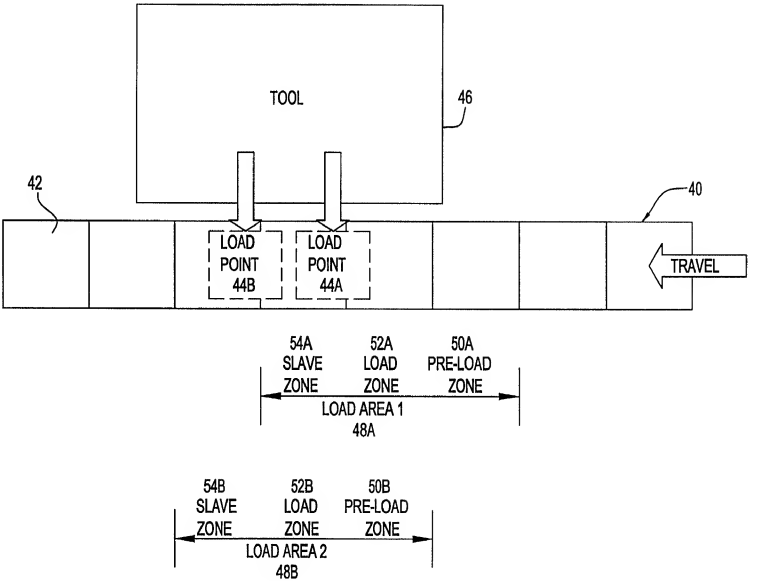

TOOL
46
42
40
LOAD POINT 44B
LOAD POINT 44A
TRAVEL
54A SLAVE ZONE
52A LOAD ZONE
50A PRE-LOAD ZONE
LOAD AREA 1 48A
54B SLAVE ZONE
52B LOAD ZONE
50B PRE-LOAD ZONE
LOAD AREA 2 48B

FIG. 2B

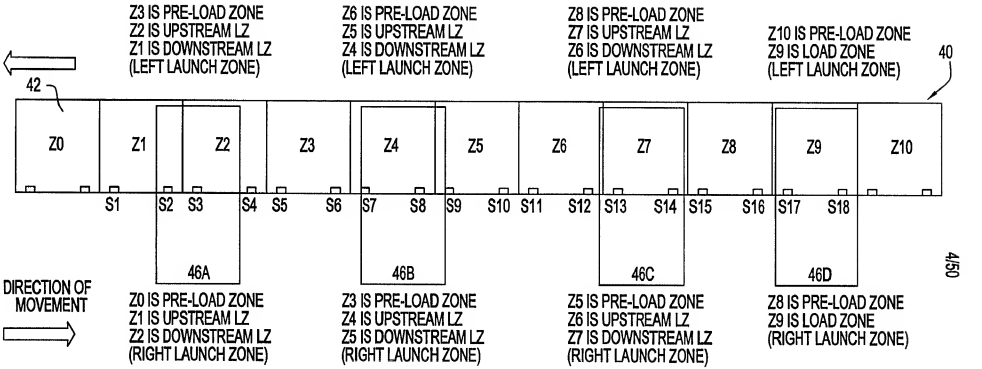

Z3 IS PRE-LOAD ZONE
Z2 IS UPSTREAM LZ
Z1 IS DOWNSTREAM LZ
(LEFT LAUNCH ZONE)
Z6 IS PRE-LOAD ZONE
Z5 IS UPSTREAM LZ
Z4 IS DOWNSTREAM LZ
(LEFT LAUNCH ZONE)
Z8 IS PRE-LOAD ZONE
Z7 IS UPSTREAM LZ
Z6 IS DOWNSTREAM LZ
(LEFT LAUNCH ZONE)
Z10 IS PRE-LOAD ZONE
Z9 IS LOAD ZONE
(LEFT LAUNCH ZONE)
40
42
Z0
Z1
Z2
Z3
Z4
Z5
Z6
Z7
Z8
Z9
Z10
S1
S2
S3
S4
S5
S6
S7
S8
S9
S10
S11
S12
S13
S14
S15
S16
S17
S18
46A
46B
46C
46D
450
DIRECTION OF MOVEMENT
Z0 IS PRE-LOAD ZONE
Z1 IS UPSTREAM LZ
Z2 IS DOWNSTREAM LZ
(RIGHT LAUNCH ZONE)
Z3 IS PRE-LOAD ZONE
Z4 IS UPSTREAM LZ
Z5 IS DOWNSTREAM LZ
(RIGHT LAUNCH ZONE)
Z5 IS PRE-LOAD ZONE
Z6 IS UPSTREAM LZ
Z7 IS DOWNSTREAM LZ
(RIGHT LAUNCH ZONE)
Z8 IS PRE-LOAD ZONE
Z9 IS LOAD ZONE
(RIGHT LAUNCH ZONE)

FIG. 2C

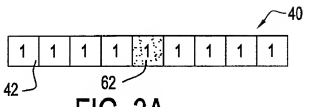


FIG. 3A

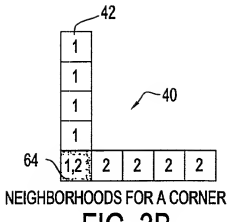


FIG. 3B

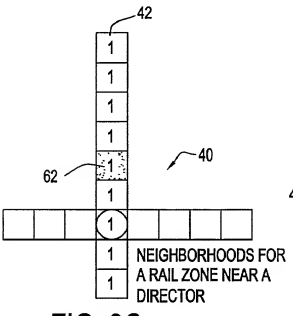


FIG. 3C

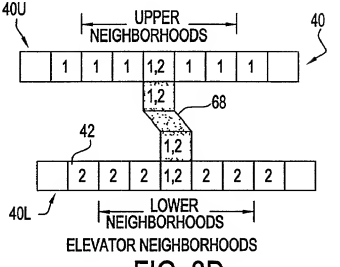


FIG. 3D

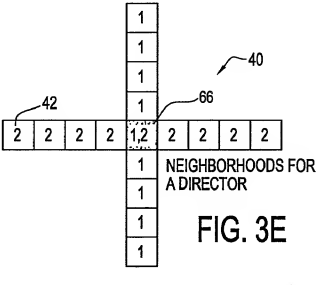


FIG. 3E

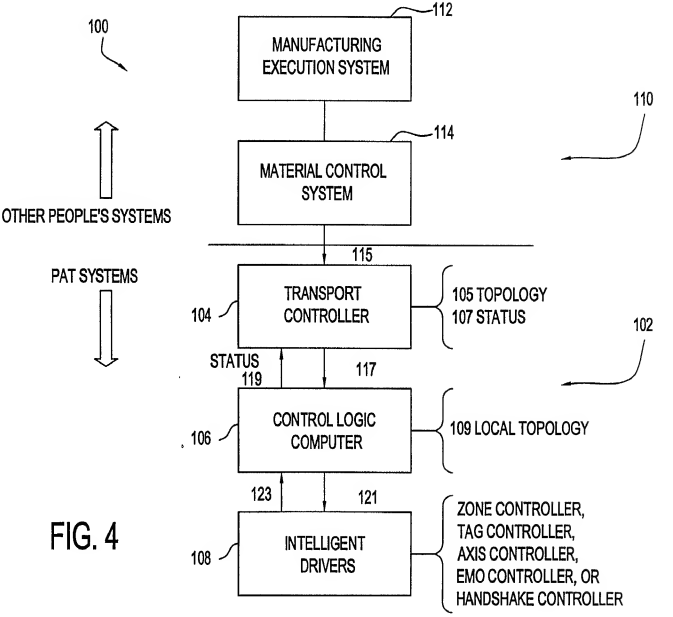

100
112
MANUFACTURING EXECUTION SYSTEM
110
114
MATERIAL CONTROL SYSTEM
OTHER PEOPLE'S SYSTEMS
115
PAT SYSTEMS
TRANSPORT CONTROLLER
104
105 TOPOLOGY
107 STATUS
102
STATUS
119
117
CONTROL LOGIC COMPUTER
106
109 LOCAL TOPOLOGY
123
121
INTELLIGENT DRIVERS
108
ZONE CONTROLLER,
TAG CONTROLLER,
AXIS CONTROLLER,
EMO CONTROLLER, OR
HANDSHAKE CONTROLLER

FIG. 4

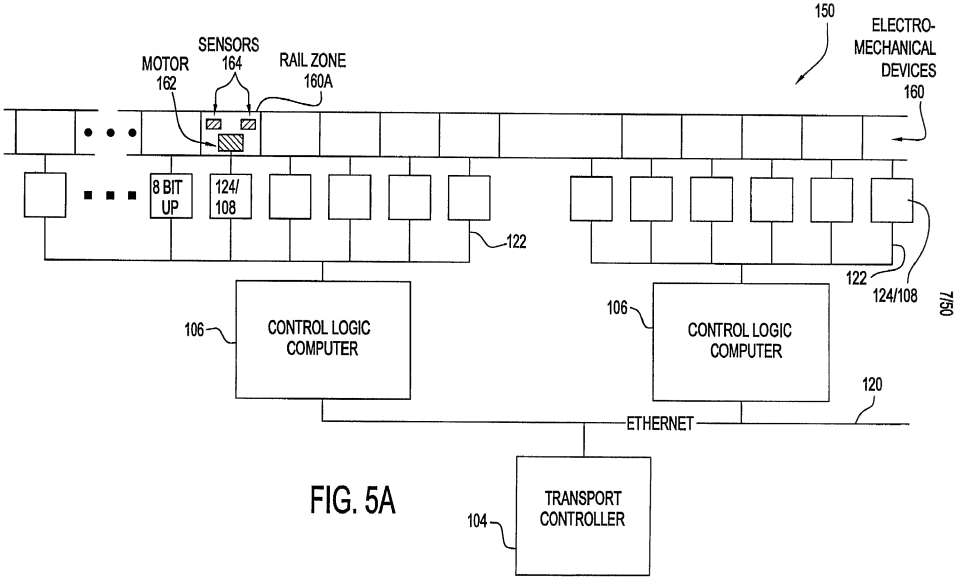

150
ELECTRO-
MECHANICAL
DEVICES
160
SENSORS
164
MOTOR
162
RAIL ZONE
160A
8 BIT
UP
124/
108
122
122
124/108
106
CONTROL LOGIC
COMPUTER
106
CONTROL LOGIC
COMPUTER
120
ETHERNET
TRANSPORT
CONTROLLER
104

FIG. 5A

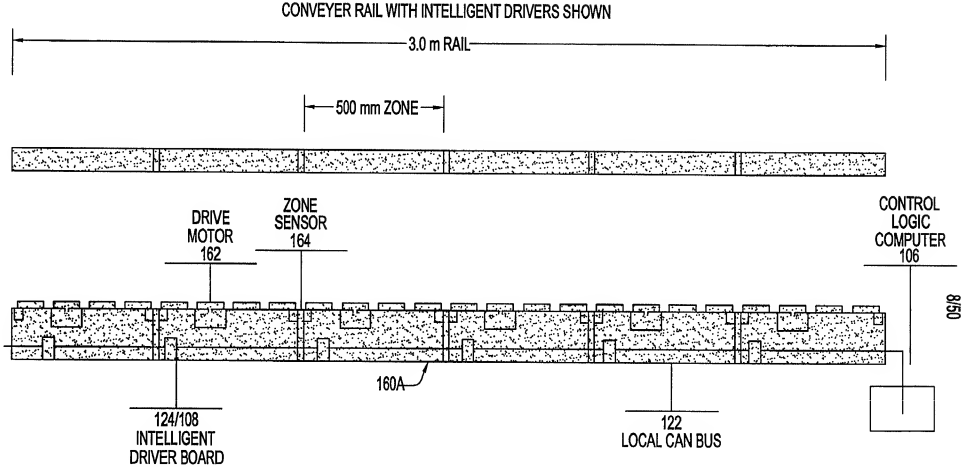

CONVEYER RAIL WITH INTELLIGENT DRIVERS SHOWN
3.0 m RAIL
500 mm ZONE
DRIVE MOTOR 162
ZONE SENSOR 164
CONTROL LOGIC COMPUTER 106
160A
124/108 INTELLIGENT DRIVER BOARD
122 LOCAL CAN BUS

FIG. 5B

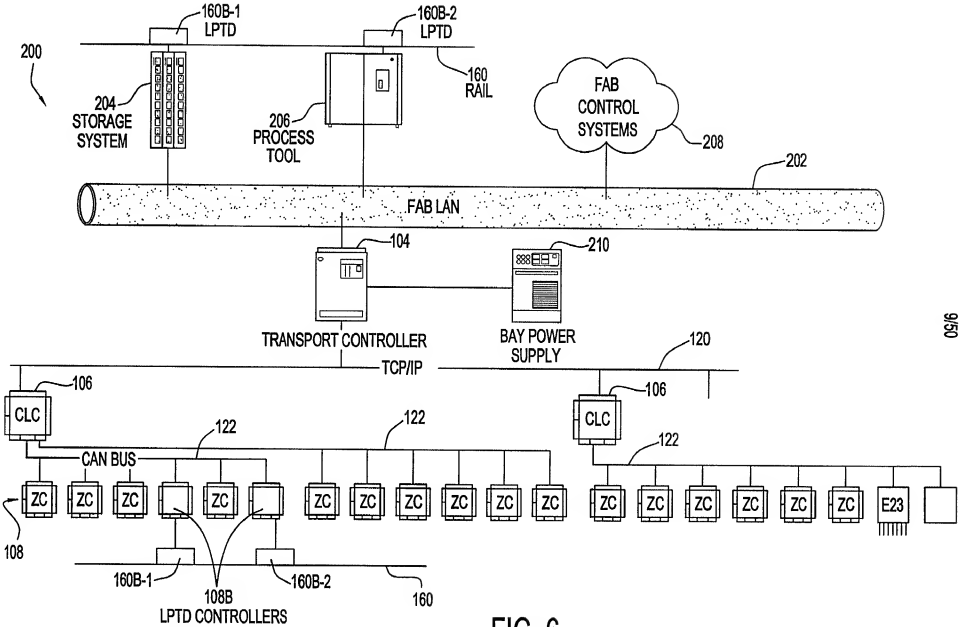

200
160B-1
LPTD
160B-2
LPTD
160
RAIL
204
STORAGE
SYSTEM
206
PROCESS
TOOL
FAB
CONTROL
SYSTEMS
208
202
FAB LAN
104
210
TRANSPORT CONTROLLER
BAY POWER
SUPPLY
120
TCP/IP
106
CLC
106
CLC
122
122
122
CAN BUS
ZC
E23
108
160B-1
108B
160B-2
160
LPTD CONTROLLERS

FIG. 6

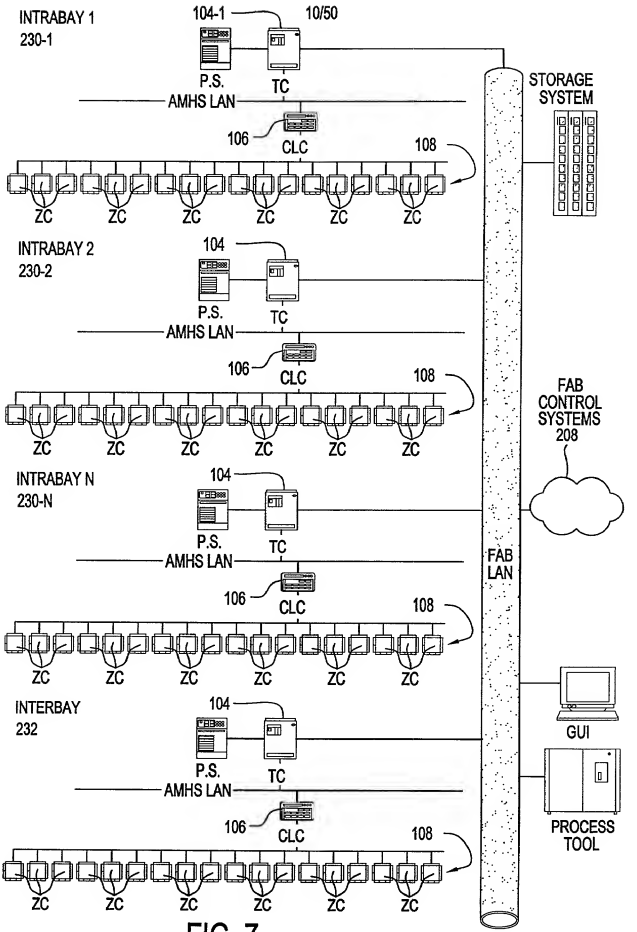

INTRABAY 1
230-1
104-1
10/50
P.S.
TC
AMHS LAN
106
CLC
108
ZC
ZC
ZC
ZC
ZC
ZC
INTRABAY 2
230-2
104
P.S.
TC
AMHS LAN
106
CLC
108
ZC
ZC
ZC
ZC
ZC
ZC
INTRABAY N
230-N
104
P.S.
TC
AMHS LAN
106
CLC
108
ZC
ZC
ZC
ZC
ZC
ZC
INTERBAY
232
104
P.S.
TC
AMHS LAN
106
CLC
108
ZC
ZC
ZC
ZC
ZC
ZC
STORAGE
SYSTEM
FAB
CONTROL
SYSTEMS
208
FAB
LAN
GUI
PROCESS
TOOL

FIG. 7

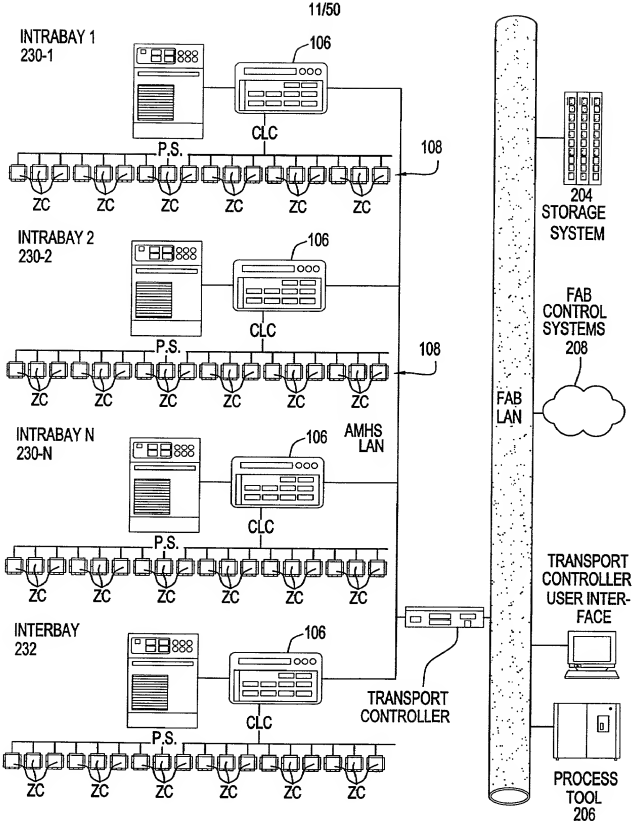

INTRABAY 1
230-1
106
CLC
P.S.
108
ZC
ZC
ZC
ZC
ZC
ZC
INTRABAY 2
230-2
106
CLC
P.S.
108
ZC
ZC
ZC
ZC
ZC
ZC
INTRABAY N
230-N
106
AMHS
LAN
CLC
P.S.
ZC
ZC
ZC
ZC
ZC
ZC
INTERBAY
232
106
CLC
P.S.
ZC
ZC
ZC
ZC
ZC
ZC
TRANSPORT
CONTROLLER
204
STORAGE
SYSTEM
FAB
CONTROL
SYSTEMS
208
FAB
LAN
TRANSPORT
CONTROLLER
USER INTER-
FACE
PROCESS
TOOL
206

FIG. 8

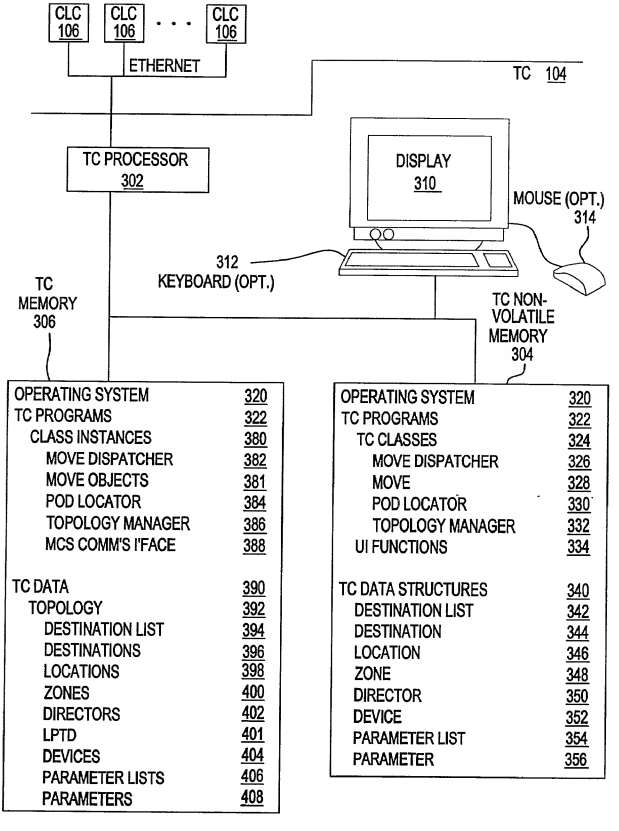

CLC 106
CLC 106
CLC 106
ETHERNET
TC 104
TC PROCESSOR 302
DISPLAY 310
MOUSE (OPT.) 314
312 KEYBOARD (OPT.)
TC MEMORY 306
TC NON-VOLATILE MEMORY 304
OPERATING SYSTEM 320
TC PROGRAMS 322
CLASS INSTANCES 380
MOVE DISPATCHER 382
MOVE OBJECTS 381
POD LOCATOR 384
TOPOLOGY MANAGER 386
MCS COMM'S I'FACE 388
TC DATA 390
TOPOLOGY 392
DESTINATION LIST 394
DESTINATIONS 396
LOCATIONS 398
ZONES 400
DIRECTORS 402
LPTD 401
DEVICES 404
PARAMETER LISTS 406
PARAMETERS 408
OPERATING SYSTEM 320
TC PROGRAMS 322
TC CLASSES 324
MOVE DISPATCHER 326
MOVE 328
POD LOCATOR 330
TOPOLOGY MANAGER 332
UI FUNCTIONS 334
TC DATA STRUCTURES 340
DESTINATION LIST 342
DESTINATION 344
LOCATION 346
ZONE 348
DIRECTOR 350
DEVICE 352
PARAMETER LIST 354
PARAMETER 356

FIG. 9A

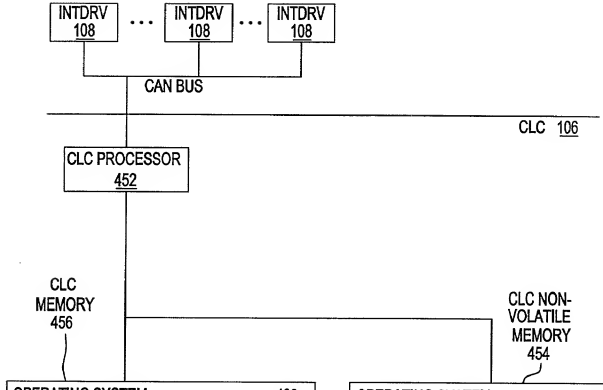

INTDRV 108
INTDRV 108
INTDRV 108
CAN BUS
CLC 106
CLC PROCESSOR 452
CLC MEMORY 456
CLC NON-VOLATILE MEMORY 454
OPERATING SYSTEM 460
CLC PROGRAMS 462
CLASS INSTANCES/THREADS 510
ZONE THREADS 512
LAC THREADS 514
HEALTH MTR THREADS 516
LPTD CTRL THDS 518
DIRECTOR CTL THDS 520
CLC DATA 530
CLC TOPOLOGY 532
CLC STATUS 534
OPERATING SYSTEM 460
CLC PROGRAMS 462
CLC CLASSES 464
ZONE 466
ZONE DATA STRUCTS 470
LAC 472
LAC DATA STRUCTS 474
HEALTH MONITOR 476
HM DATA STRUCTS 478
LPTD CTRL 480
LPTD DATA STRUCTS 482
DIRECTOR CTRL 484
ZONE DATA STRUCTS 486
CLC STATE MACHINES 488
ZONE STATE MACHINE 490
LAC STATE MACHINE 492
HM STATE MACHINE 494
LPTD STATE MACHINE 496
LAC STATE MACHINE 498
CLC DATA STRUCTURES 500
TOPOLOGY STRUCTURES 502

FIG. 9B

PCT/US03/25025

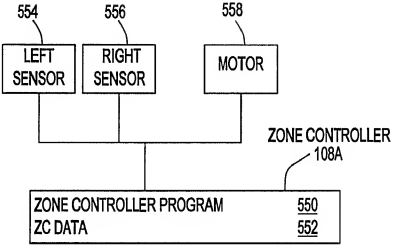


FIG. 9C

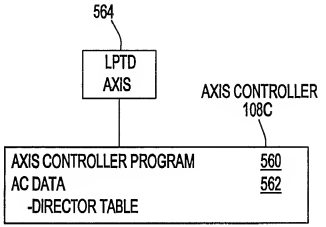


FIG. 9D

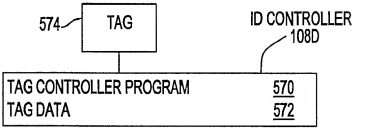


FIG. 9E

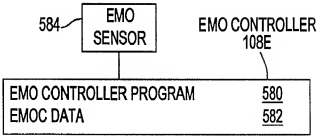


FIG. 9F

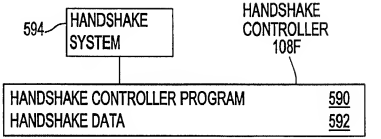


FIG. 9G

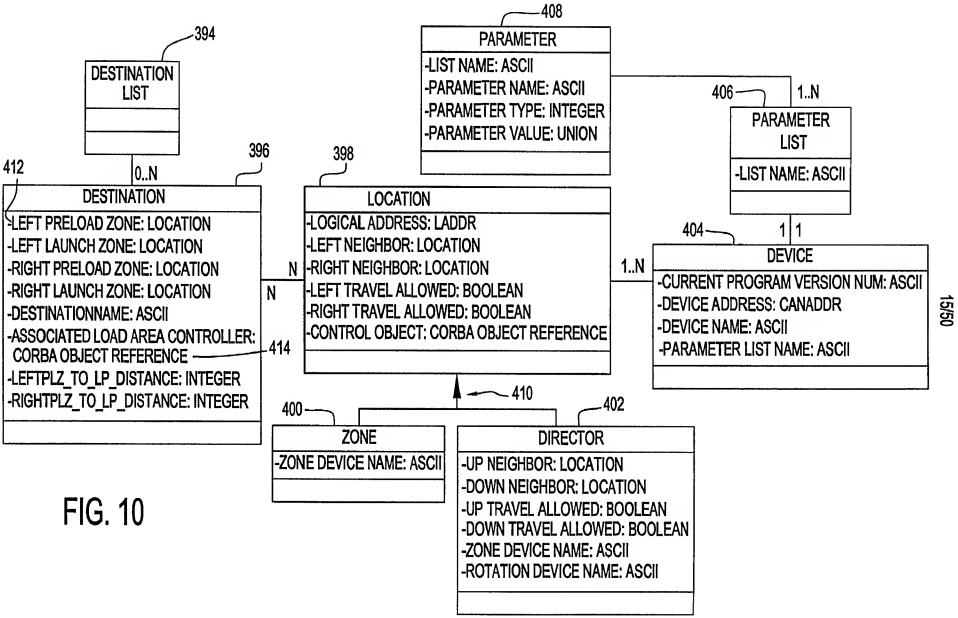

394
DESTINATION LIST
408
PARAMETER
-LIST NAME: ASCII
-PARAMETER NAME: ASCII
-PARAMETER TYPE: INTEGER
-PARAMETER VALUE: UNION
406
1..N
PARAMETER LIST
-LIST NAME: ASCII
412
0..N
396
DESTINATION
-LEFT PRELOAD ZONE: LOCATION
-LEFT LAUNCH ZONE: LOCATION
-RIGHT PRELOAD ZONE: LOCATION
-RIGHT LAUNCH ZONE: LOCATION
-DESTINATIONNAME: ASCII
-ASSOCIATED LOAD AREA CONTROLLER: CORBA OBJECT REFERENCE
414
-LEFTPLZ_TO_LP_DISTANCE: INTEGER
-RIGHTPLZ_TO_LP_DISTANCE: INTEGER
398
LOCATION
-LOGICAL ADDRESS: LADDR
-LEFT NEIGHBOR: LOCATION
-RIGHT NEIGHBOR: LOCATION
-LEFT TRAVEL ALLOWED: BOOLEAN
-RIGHT TRAVEL ALLOWED: BOOLEAN
-CONTROL OBJECT: CORBA OBJECT REFERENCE
N
N
1..N
404
1
1
DEVICE
-CURRENT PROGRAM VERSION NUM: ASCII
-DEVICE ADDRESS: CANADDR
-DEVICE NAME: ASCII
-PARAMETER LIST NAME: ASCII
410
400
ZONE
-ZONE DEVICE NAME: ASCII
402
DIRECTOR
-UP NEIGHBOR: LOCATION
-DOWN NEIGHBOR: LOCATION
-UP TRAVEL ALLOWED: BOOLEAN
-DOWN TRAVEL ALLOWED: BOOLEAN
-ZONE DEVICE NAME: ASCII
-ROTATION DEVICE NAME: ASCII
1950

FIG. 10

PCT/US97/23650

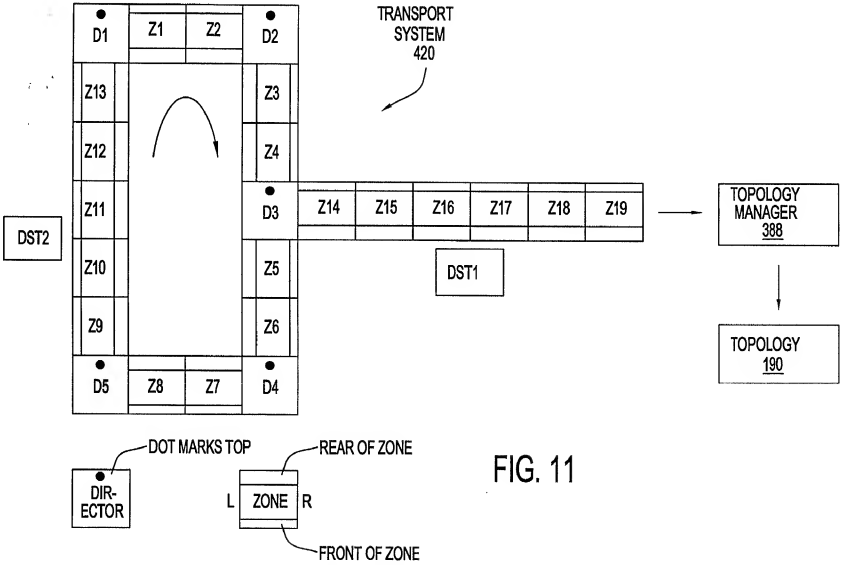


FIG. 11

TOPOLOGY 392

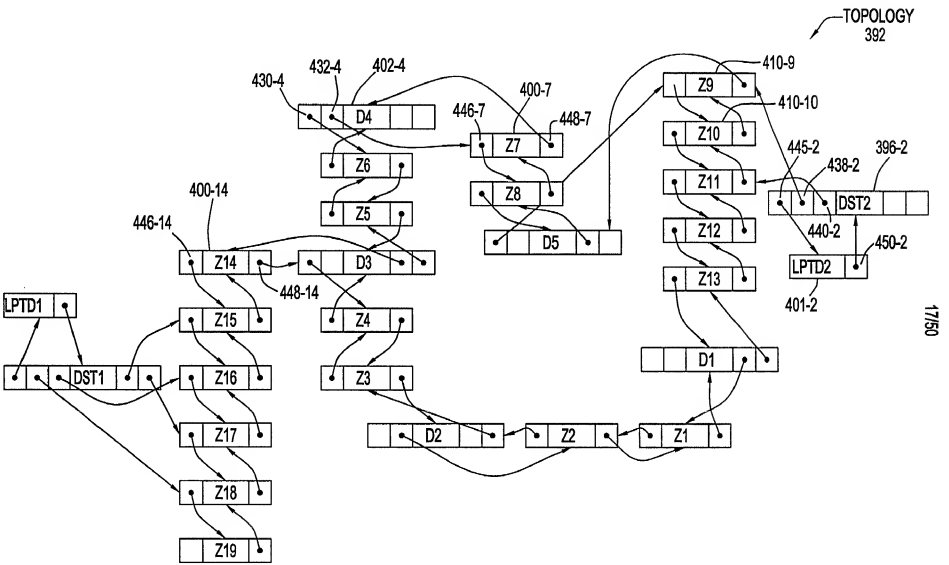


FIG. 12A

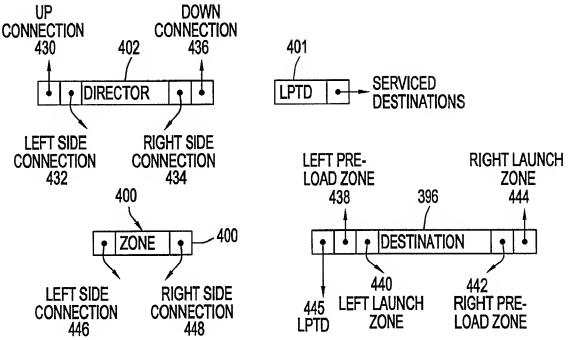
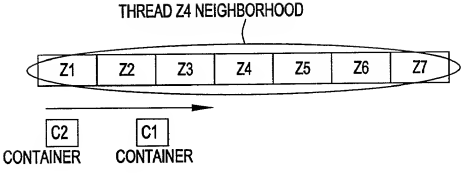

UP CONNECTION 430
402
DOWN CONNECTION 436
DIRECTOR
LEFT SIDE CONNECTION 432
RIGHT SIDE CONNECTION 434
400
ZONE
400
LEFT SIDE CONNECTION 446
RIGHT SIDE CONNECTION 448
401
LPTD
SERVICED DESTINATIONS
LEFT PRE-LOAD ZONE 438
396
RIGHT LAUNCH ZONE 444
DESTINATION
445 LPTD
440 LEFT LAUNCH ZONE
442 RIGHT PRE-LOAD ZONE

FIG. 12B



ZONE Z4 THREAD 512-4

ZONE STATE MACHINE	620
ZONE THREAD METHODS	622
ZONE Z4 DATA	624
NEIGHBOR STATUS:	626
ZONE Z1 STATUS	628
STATUS {CARRIER EXITING, CARRIER EXITED, CARRIER STOPPED, CARRIER REMOVED, ZONE AVAILABLE, ZONE RESERVED}; MAXIMUM SPEED;	630
ZONE Z2 STATUS	632
ZONE Z3 STATUS	634
ZONE Z5 STATUS	636
ZONE Z6 STATUS	638
ZONE Z7 STATUS	640
CONTAINERS QUEUE	642
CONTAINER C1	644
CONTAINER C2	646
NEAREST CONTAINER PTR (=C1)	648
...	
DOWNSTREAM SPEED TABLE;	670
UPSTREAM SPEED COMMAND;	672
MAXIMUM SPEED;	674
SPEED TABLE RULES)	676

FIG. 13

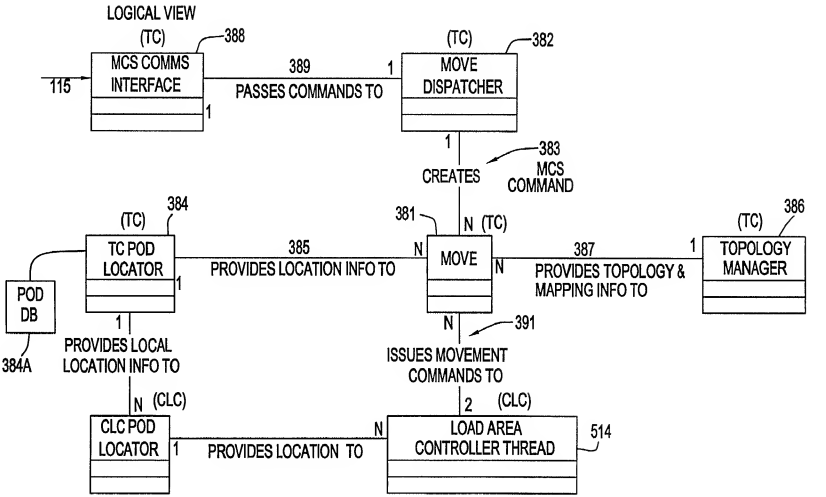

LOGICAL VIEW
(TC)
388
MCS COMMS INTERFACE
115
1
389
PASSES COMMANDS TO
1
(TC)
382
MOVE DISPATCHER
1
CREATES
383
MCS COMMAND
(TC)
384
TC POD LOCATOR
1
385
PROVIDES LOCATION INFO TO
N
381
N (TC)
MOVE
N
387
PROVIDES TOPOLOGY & MAPPING INFO TO
1
(TC)
386
TOPOLOGY MANAGER
POD DB
384A
1
PROVIDES LOCAL LOCATION INFO TO
N
391
ISSUES MOVEMENT COMMANDS TO
N (CLC)
CLC POD LOCATOR
1
PROVIDES LOCATION TO
N
2 (CLC)
LOAD AREA CONTROLLER THREAD
514

FIG. 14

2050

PCT/US2005/

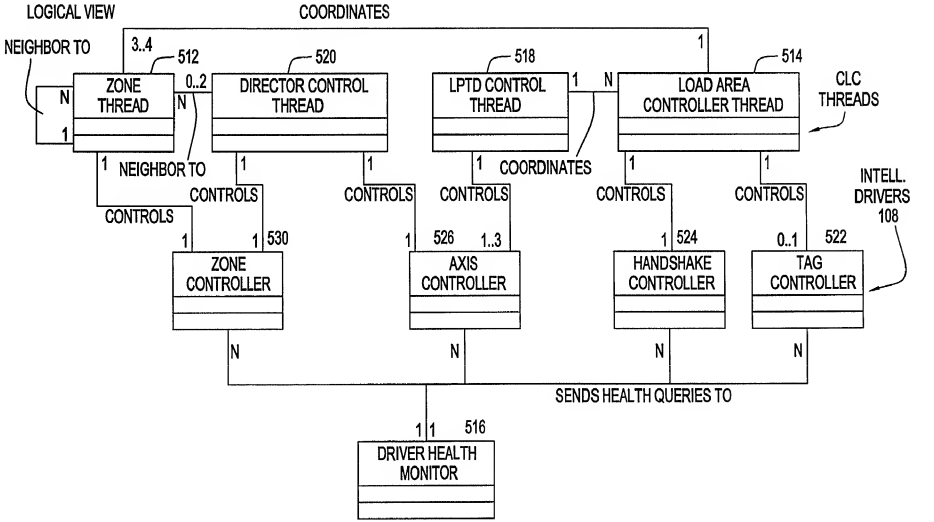
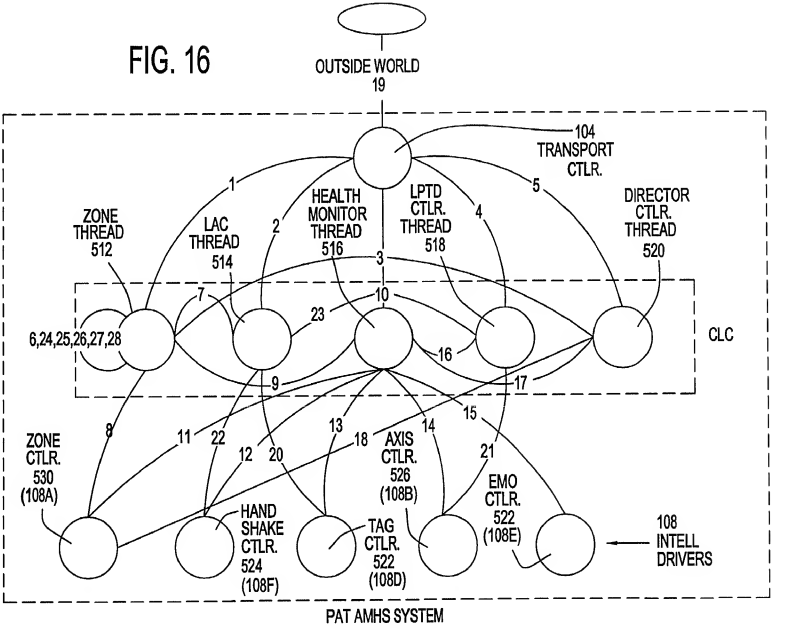


FIG. 15

PCT/US03/32260

FIG. 16



PCT/US2005/045045

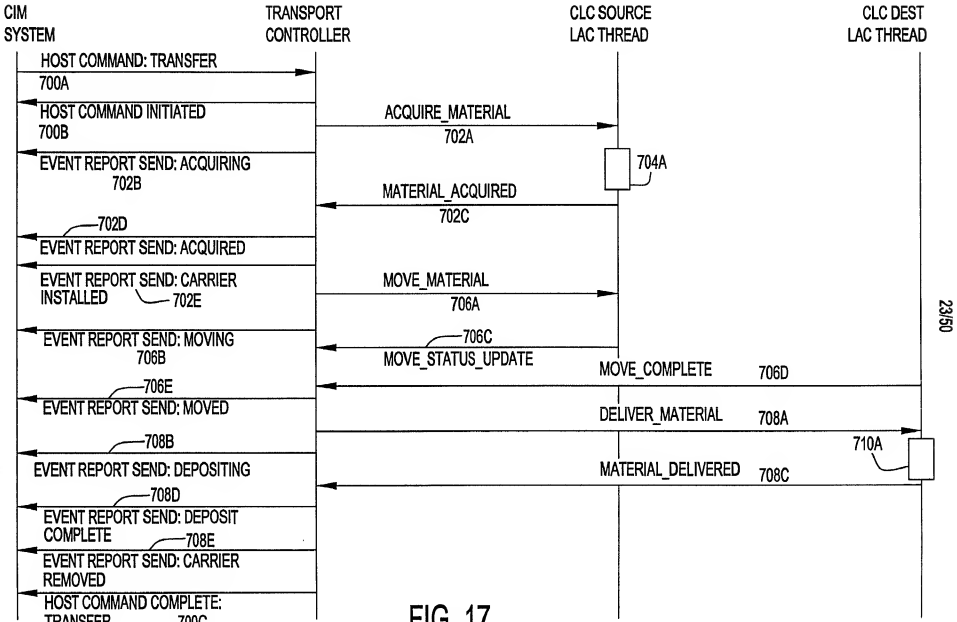


FIG. 17

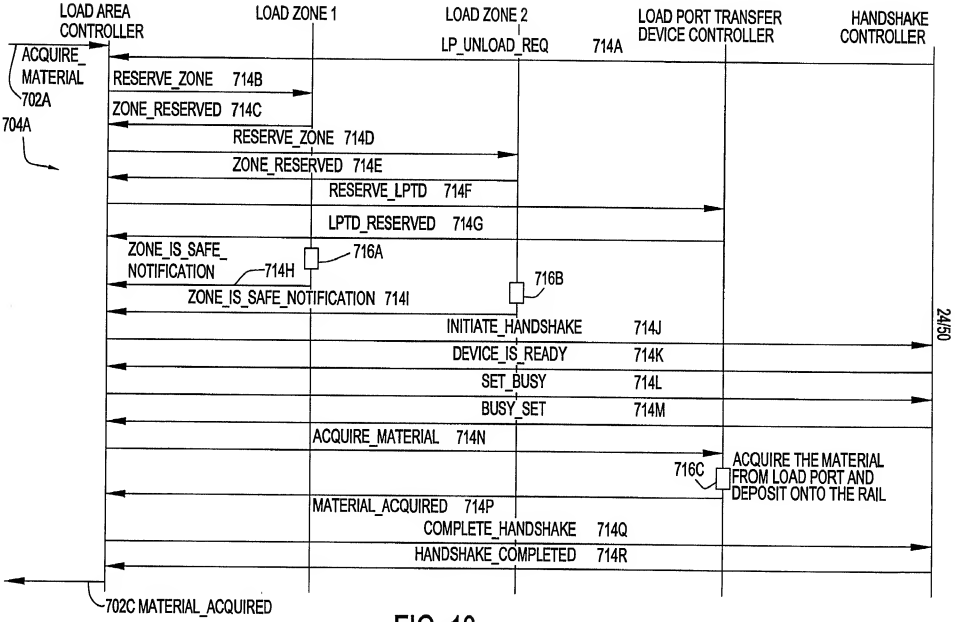

LOAD AREA CONTROLLER
LOAD ZONE 1
LOAD ZONE 2
LOAD PORT TRANSFER DEVICE CONTROLLER
HANDSHAKE CONTROLLER
ACQUIRE_ MATERIAL 702A
704A
LP_UNLOAD_REQ 714A
RESERVE_ZONE 714B
ZONE_RESERVED 714C
RESERVE_ZONE 714D
ZONE_RESERVED 714E
RESERVE_LPTD 714F
LPTD_RESERVED 714G
ZONE_IS_SAFE_ NOTIFICATION 714H
716A
716B
ZONE_IS_SAFE_NOTIFICATION 714I
INITIATE_HANDSHAKE 714J
DEVICE_IS_READY 714K
SET_BUSY 714L
BUSY_SET 714M
ACQUIRE_MATERIAL 714N
716C
ACQUIRE THE MATERIAL FROM LOAD PORT AND DEPOSIT ONTO THE RAIL
MATERIAL_ACQUIRED 714P
COMPLETE_HANDSHAKE 714Q
HANDSHAKE_COMPLETED 714R
702C MATERIAL_ACQUIRED
24/50

FIG. 18

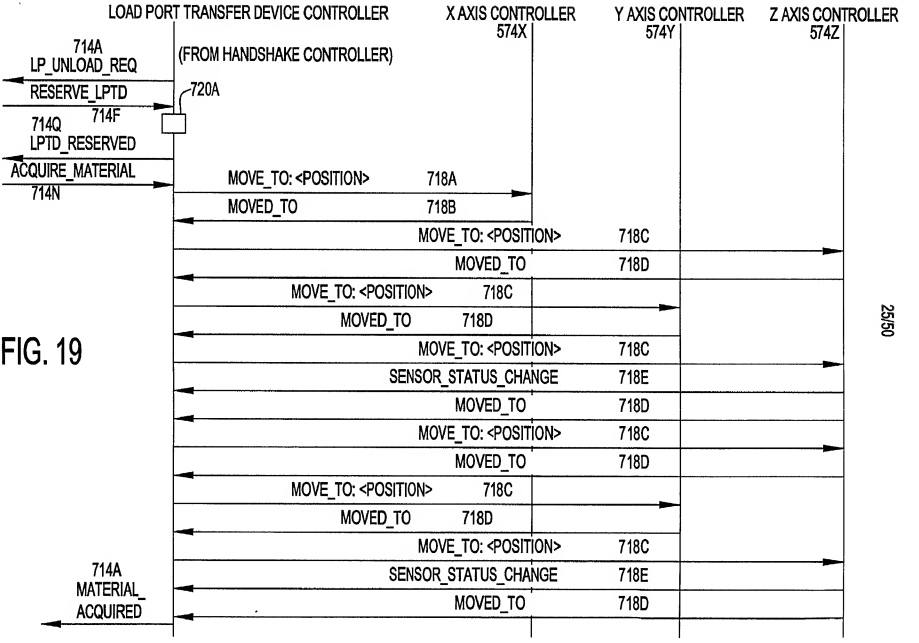

LOAD PORT TRANSFER DEVICE CONTROLLER
X AXIS CONTROLLER 574X
Y AXIS CONTROLLER 574Y
Z AXIS CONTROLLER 574Z
714A LP_UNLOAD_REQ
(FROM HANDSHAKE CONTROLLER)
RESERVE_LPTD
720A
714F
714Q LPTD_RESERVED
ACQUIRE_MATERIAL
714N
MOVE_TO: <POSITION> 718A
MOVED_TO 718B
MOVE_TO: <POSITION> 718C
MOVED_TO 718D
MOVE_TO: <POSITION> 718C
MOVED_TO 718D
MOVE_TO: <POSITION> 718C
SENSOR_STATUS_CHANGE 718E
MOVED_TO 718D
MOVE_TO: <POSITION> 718C
MOVED_TO 718D
MOVE_TO: <POSITION> 718C
MOVED_TO 718D
MOVE_TO: <POSITION> 718C
714A MATERIAL_ ACQUIRED
SENSOR_STATUS_CHANGE 718E
MOVED_TO 718D

FIG. 19

PCT/US 05/36040

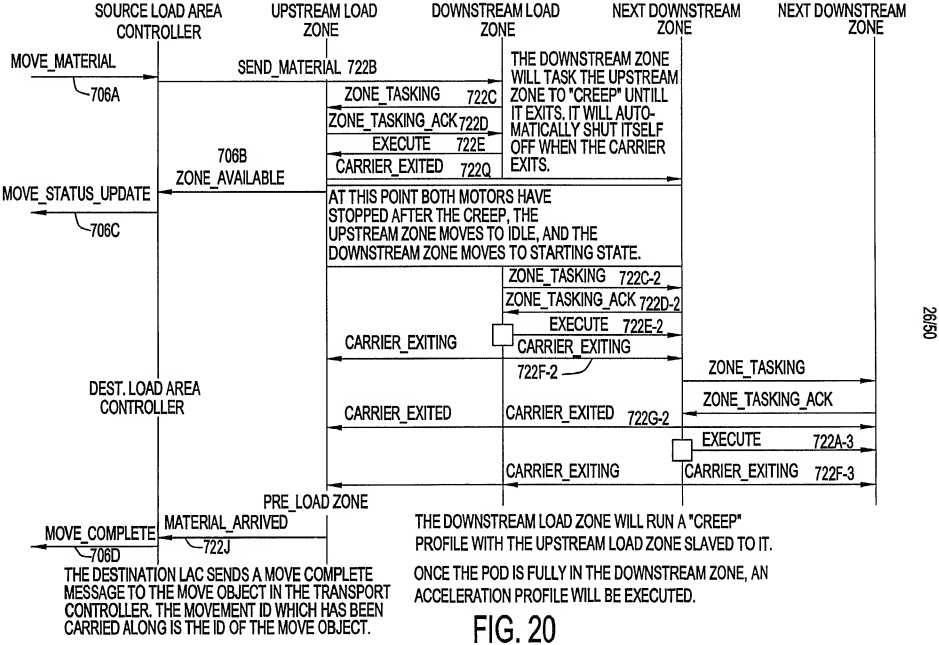
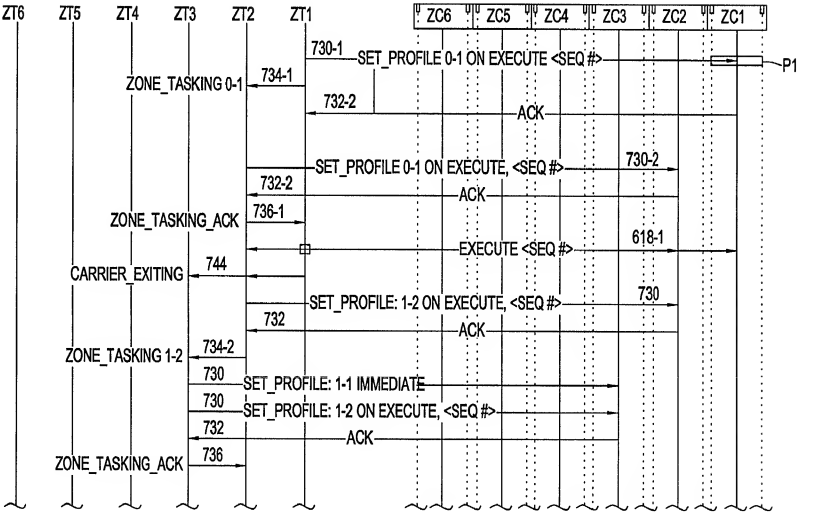


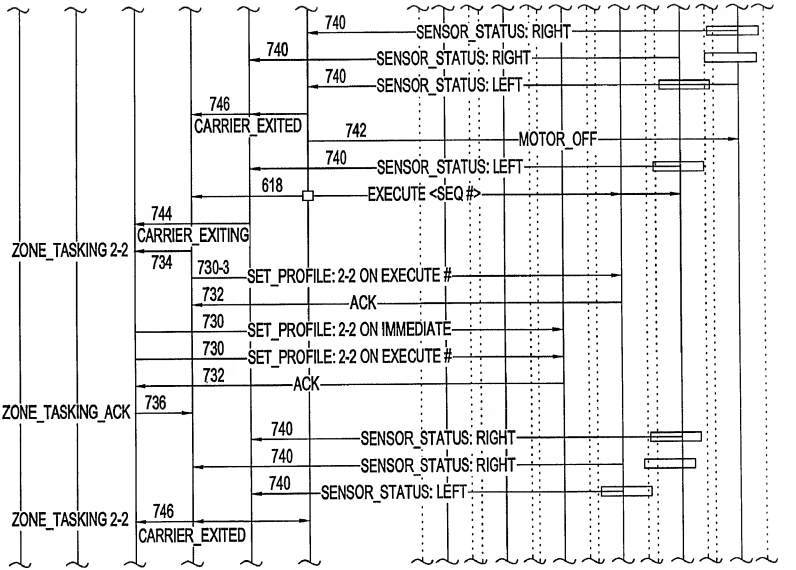
FIG. 20

RESTRICTED



CONTINUED TO FIG. 21B

FIG. 21 A



CONTINUED TO FIG. 21C

FIG. 21B

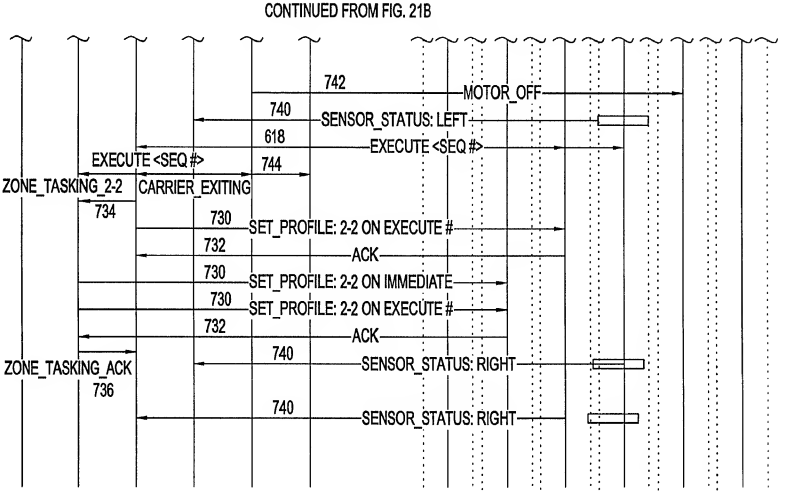
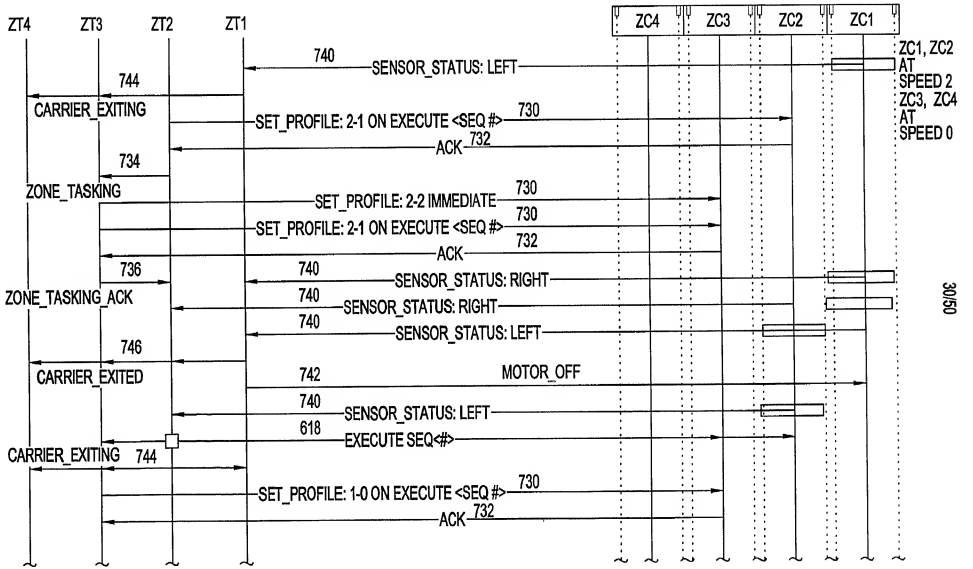

CONTINUED FROM FIG. 21B
742
MOTOR_OFF
740
SENSOR_STATUS: LEFT
618
EXECUTE <SEQ #>
EXECUTE <SEQ #>
744
ZONE_TASKING_2-2
CARRIER_EXITING
734
730
SET_PROFILE: 2-2 ON EXECUTE #
732
ACK
730
SET_PROFILE: 2-2 ON IMMEDIATE
730
SET_PROFILE: 2-2 ON EXECUTE #
732
ACK
740
ZONE_TASKING_ACK
SENSOR_STATUS: RIGHT
736
740
SENSOR_STATUS: RIGHT

FIG. 21C

REDACTED



CONTINUED TO FIG. 22B

FIG. 22A

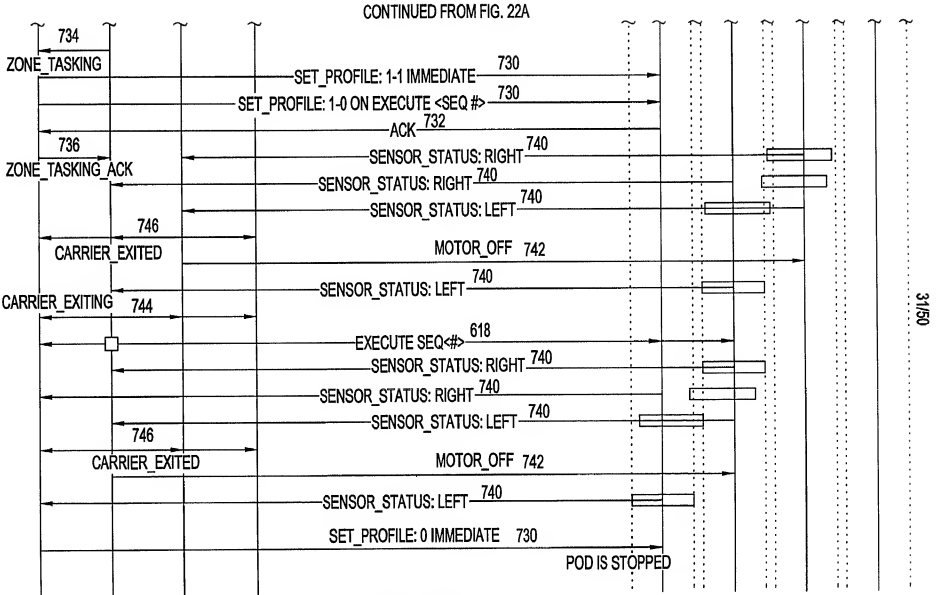
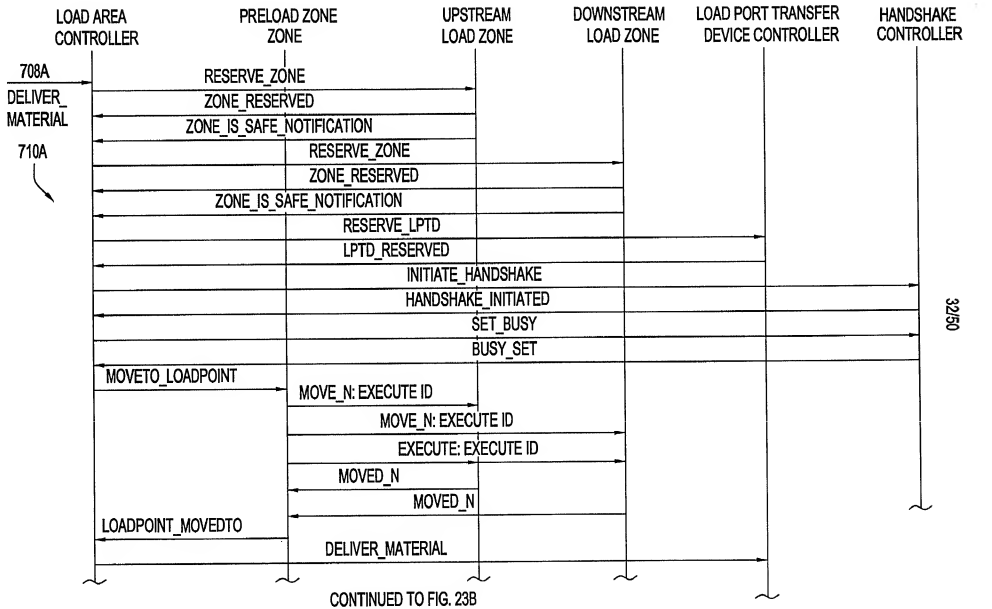

CONTINUED FROM FIG. 22A
734
ZONE_TASKING
SET_PROFILE: 1-1 IMMEDIATE 730
SET_PROFILE: 1-0 ON EXECUTE <SEQ #> 730
ACK 732
736
ZONE_TASKING_ACK
SENSOR_STATUS: RIGHT 740
SENSOR_STATUS: RIGHT 740
SENSOR_STATUS: LEFT 740
746
CARRIER_EXITED
MOTOR_OFF 742
SENSOR_STATUS: LEFT 740
CARRIER_EXITING 744
EXECUTE SEQ<#> 618
SENSOR_STATUS: RIGHT 740
SENSOR_STATUS: RIGHT 740
SENSOR_STATUS: LEFT 740
746
CARRIER_EXITED
MOTOR_OFF 742
SENSOR_STATUS: LEFT 740
SET_PROFILE: 0 IMMEDIATE 730
POD IS STOPPED

FIG. 22B



CONTINUED TO FIG. 23B

FIG. 23A

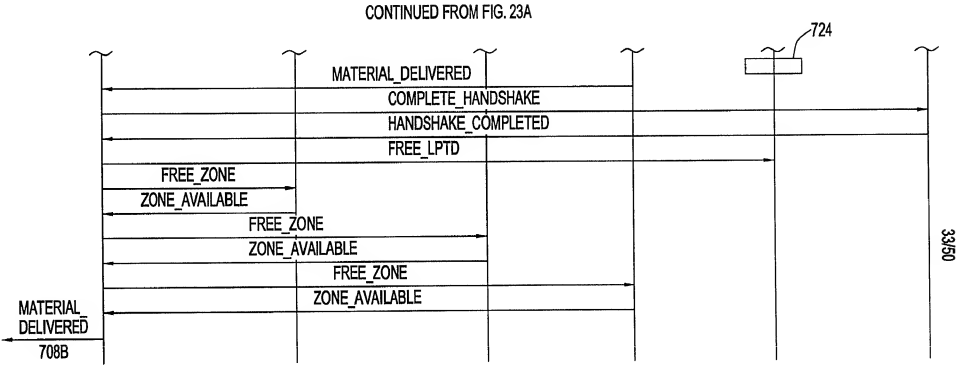

CONTINUED FROM FIG. 23A
724
MATERIAL_DELIVERED
COMPLETE_HANDSHAKE
HANDSHAKE_COMPLETED
FREE_LPTD
FREE_ZONE
ZONE_AVAILABLE
FREE_ZONE
ZONE_AVAILABLE
FREE_ZONE
ZONE_AVAILABLE
MATERIAL DELIVERED
708B
33/50

FIG. 23B

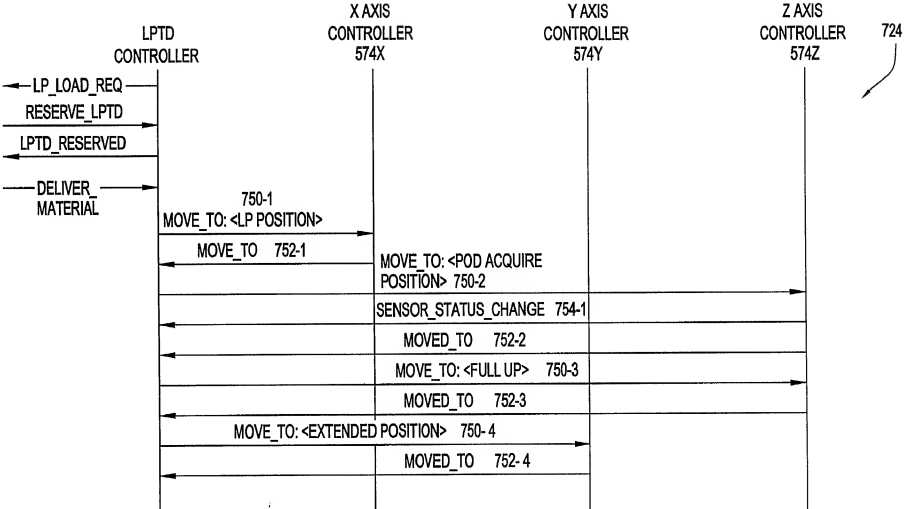

LPTD CONTROLLER
X AXIS CONTROLLER 574X
Y AXIS CONTROLLER 574Y
Z AXIS CONTROLLER 574Z
724
LP_LOAD_REQ
RESERVE_LPTD
LPTD_RESERVED
DELIVER_MATERIAL
750-1
MOVE_TO: <LP POSITION>
MOVE_TO 752-1
MOVE_TO: <POD ACQUIRE POSITION> 750-2
SENSOR_STATUS_CHANGE 754-1
MOVED_TO 752-2
MOVE_TO: <FULL UP> 750-3
MOVED_TO 752-3
MOVE_TO: <EXTENDED POSITION> 750-4
MOVED_TO 752-4

FIG. 24A

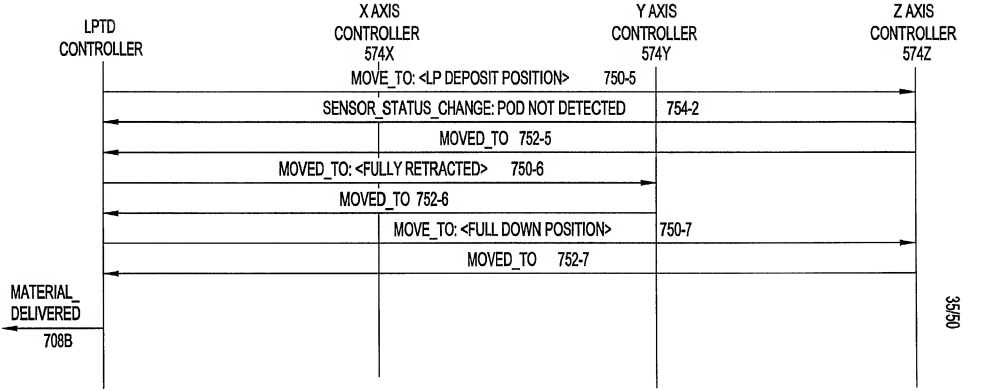

LPTD CONTROLLER
X AXIS CONTROLLER 574X
Y AXIS CONTROLLER 574Y
Z AXIS CONTROLLER 574Z
MOVE_TO: <LP DEPOSIT POSITION> 750-5
SENSOR_STATUS_CHANGE: POD NOT DETECTED 754-2
MOVED_TO 752-5
MOVED_TO: <FULLY RETRACTED> 750-6
MOVED_TO 752-6
MOVE_TO: <FULL DOWN POSITION> 750-7
MOVED_TO 752-7
MATERIAL_ DELIVERED 708B

FIG. 24B

PCT/US2005/042042

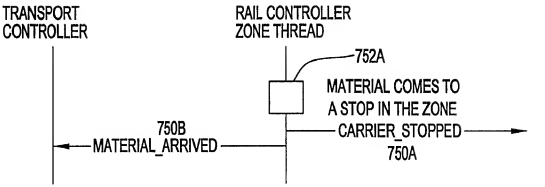


FIG. 25

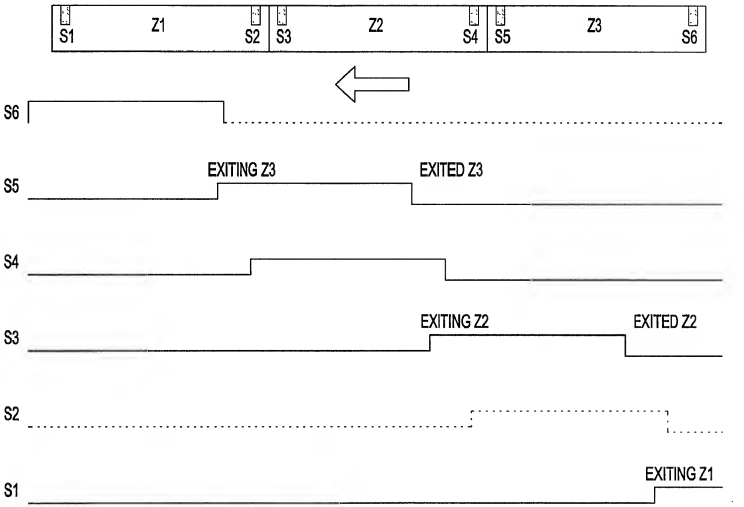

S1
Z1
S2
S3
Z2
S4
S5
Z3
S6
S6
S5
EXITING Z3
EXITED Z3
S4
S3
EXITING Z2
EXITED Z2
S2
S1
EXITING Z1

FIG. 26

REPLACEMENT SHEET

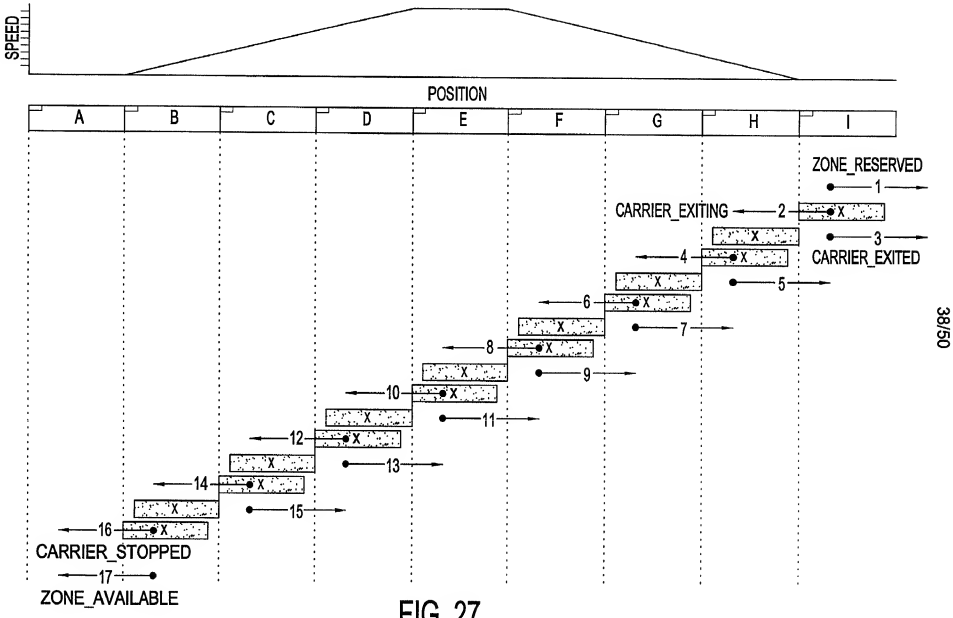


FIG. 27

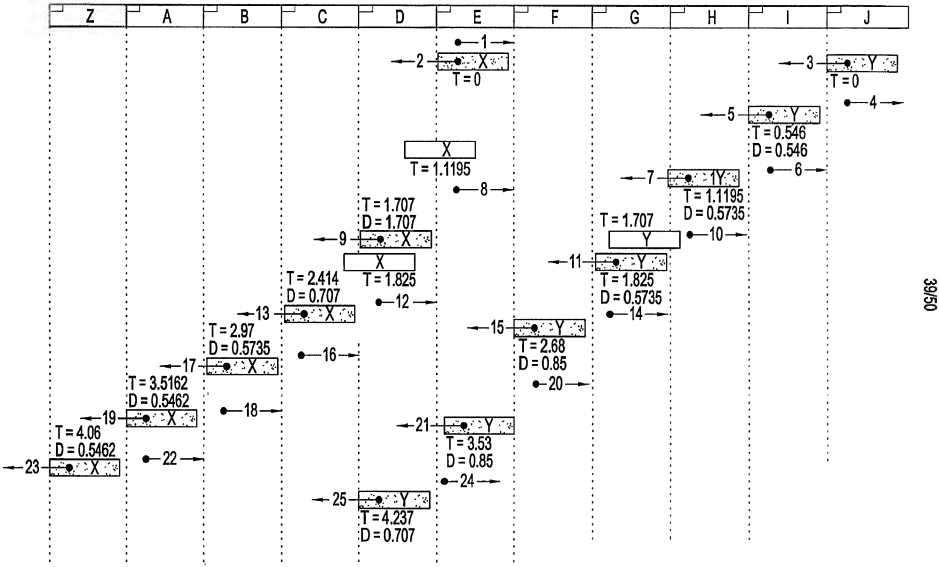
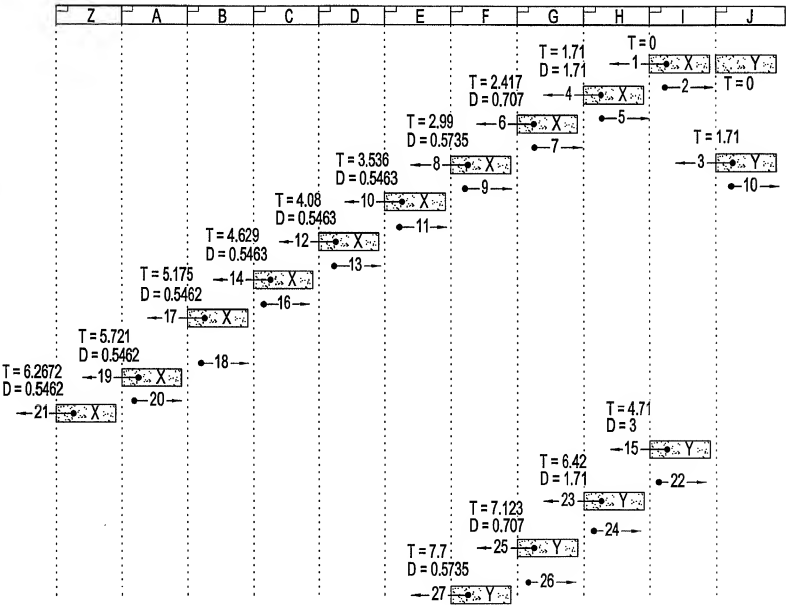

Z
A
B
C
D
E
F
G
H
I
J
1
2
X
T = 0
3
Y
T = 0
4
5
Y
T = 0.546
D = 0.546
6
X
T = 1.1195
7
1Y
T = 1.1195
D = 0.5735
8
T = 1.707
D = 1.707
9
X
T = 1.707
Y
10
11
Y
T = 1.825
D = 0.5735
14
X
T = 1.825
T = 2.414
D = 0.707
12
13
T = 2.97
D = 0.5735
X
15
Y
T = 2.68
D = 0.85
20
16
17
T = 3.5162
D = 0.5462
X
18
19
T = 4.06
D = 0.5462
X
23
22
21
Y
T = 3.53
D = 0.85
24
25
Y
T = 4.237
D = 0.707

FIG. 28

FIG. 29


Z
A
B
C
D
E
F
G
H
I
J
T = 0
1
X
Y
T = 0
2
T = 1.71
D = 1.71
4
X
5
T = 2.417
D = 0.707
T = 2.99
D = 0.5735
6
X
7
T = 1.71
3
Y
10
T = 3.536
D = 0.5463
8
X
9
T = 4.08
D = 0.5463
10
X
11
T = 4.629
D = 0.5463
12
X
13
T = 5.175
D = 0.5462
14
X
16
17
X
18
T = 5.721
D = 0.5462
T = 6.2672
D = 0.5462
19
X
20
21
X
T = 4.71
D = 3
15
Y
22
T = 6.42
D = 1.71
23
Y
24
T = 7.123
D = 0.707
25
Y
26
T = 7.7
D = 0.5735
27
Y

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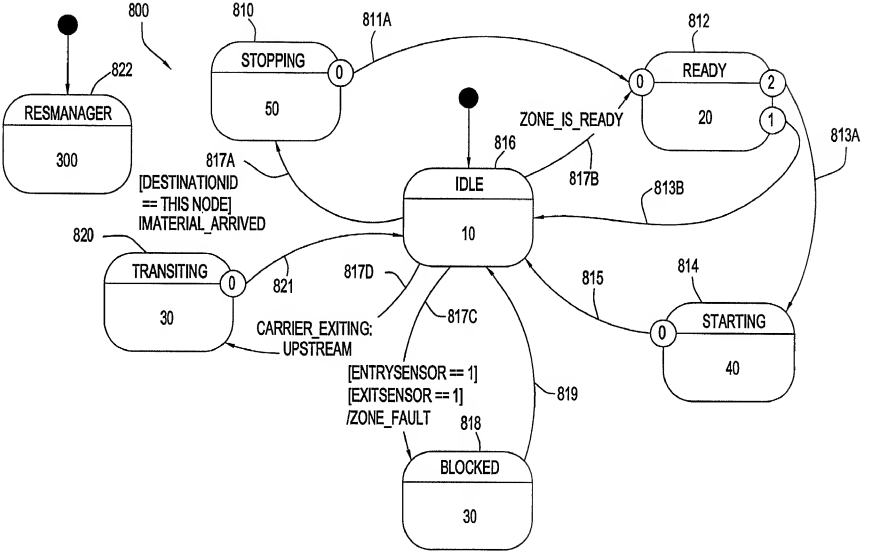

FIG. 30

PCT/US2015/064015

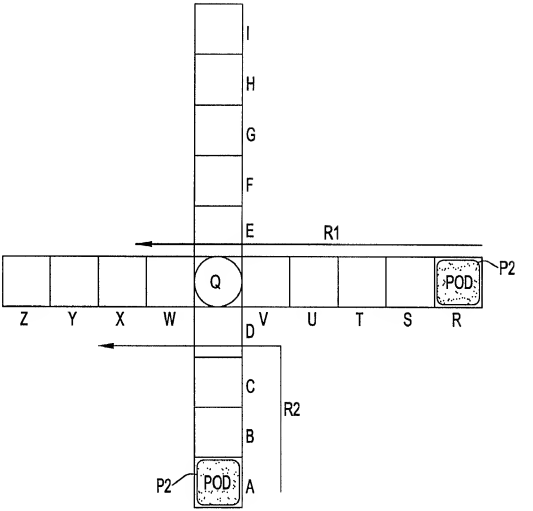

FIG. 31

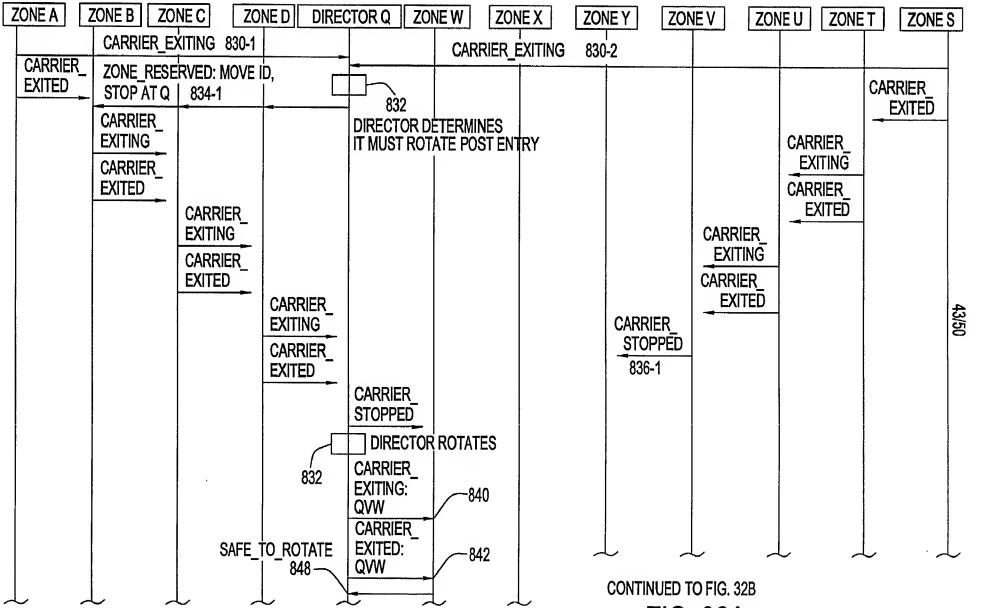
ZONE A
ZONE B
ZONE C
ZONE D
DIRECTOR Q
ZONE W
ZONE X
ZONE Y
ZONE V
ZONE U
ZONE T
ZONE S
CARRIER_EXITING 830-1
CARRIER_EXITING 830-2
CARRIER_ EXITED
ZONE_RESERVED: MOVE ID, STOP AT Q 834-1
832
DIRECTOR DETERMINES IT MUST ROTATE POST ENTRY
CARRIER_ EXITING
CARRIER_ EXITED
CARRIER_ STOPPED
836-1
DIRECTOR ROTATES
CARRIER_ EXITING: QVW
840
CARRIER_ EXITED: QVW
842
SAFE_TO_ROTATE
848
43350
CONTINUED TO FIG. 32B

FIG. 32A

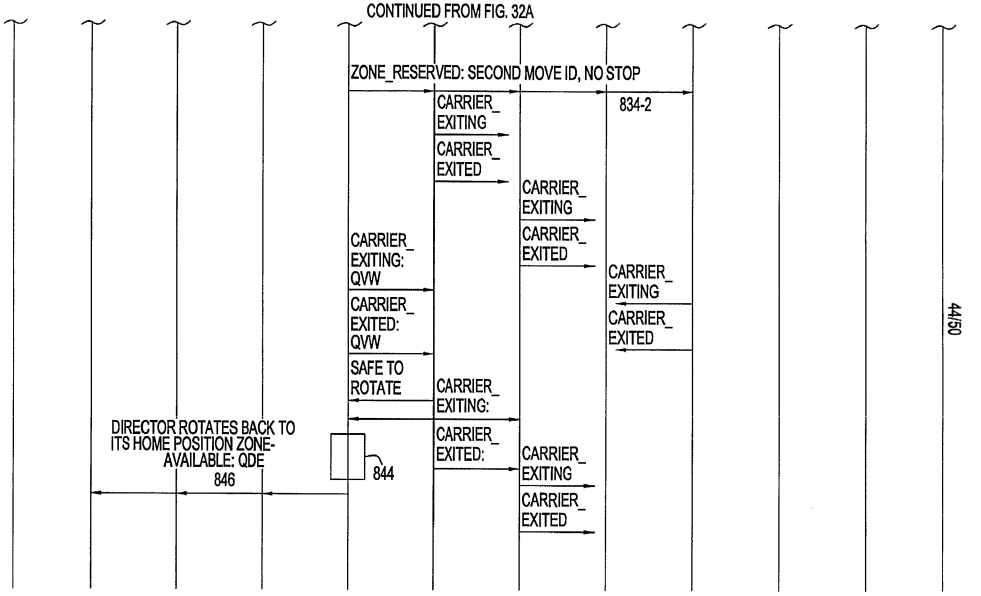
CONTINUED FROM FIG. 32A
ZONE_RESERVED: SECOND MOVE ID, NO STOP
834-2
CARRIER_ EXITING
CARRIER_ EXITED
CARRIER_ EXITING
CARRIER_ EXITED
CARRIER_ EXITING: QVW
CARRIER_ EXITED: QVW
CARRIER_ EXITING
CARRIER_ EXITED
SAFE TO ROTATE
CARRIER_ EXITING:
DIRECTOR ROTATES BACK TO ITS HOME POSITION ZONE-AVAILABLE: QDE
846
844
CARRIER_ EXITED:
CARRIER_ EXITING
CARRIER_ EXITED

FIG. 32B

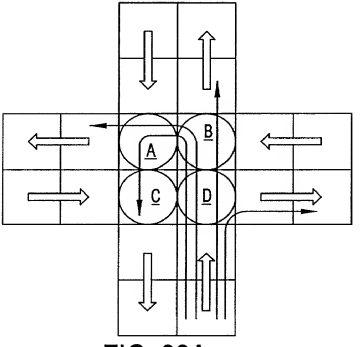

FIG. 33A

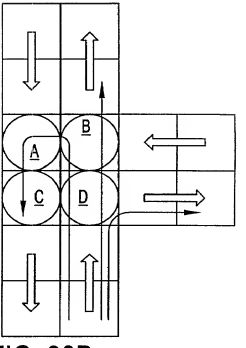

FIG. 33B

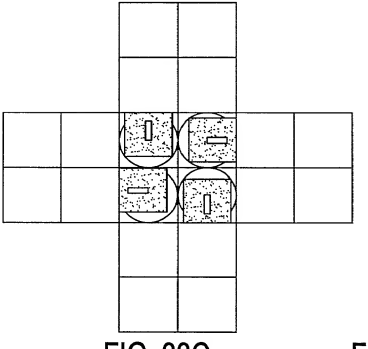

FIG. 33C

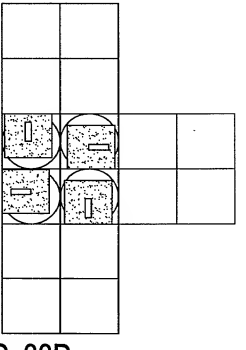

FIG. 33D

ROUTE DISCOVERY EXAMPLE:
PHYSICAL ZONE LAYOUT

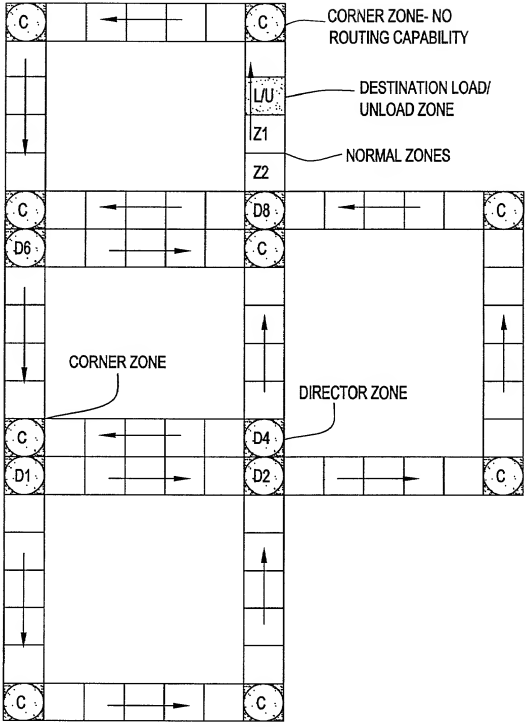

FIG. 34

PCT/US2005/045645

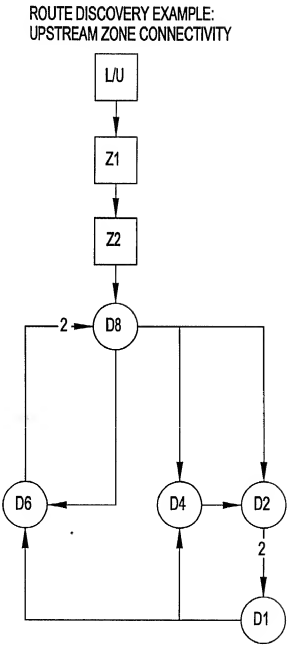

FIG. 35

ROUTE DISCOVERY EXAMPLE:
PHYSICAL ZONE LAYOUT

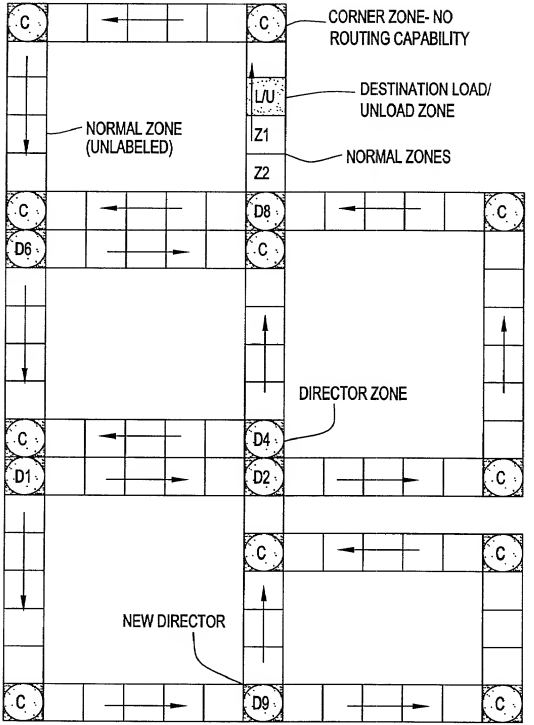

FIG. 36

FAILED NODE:
EXAMPLE LAYOUT

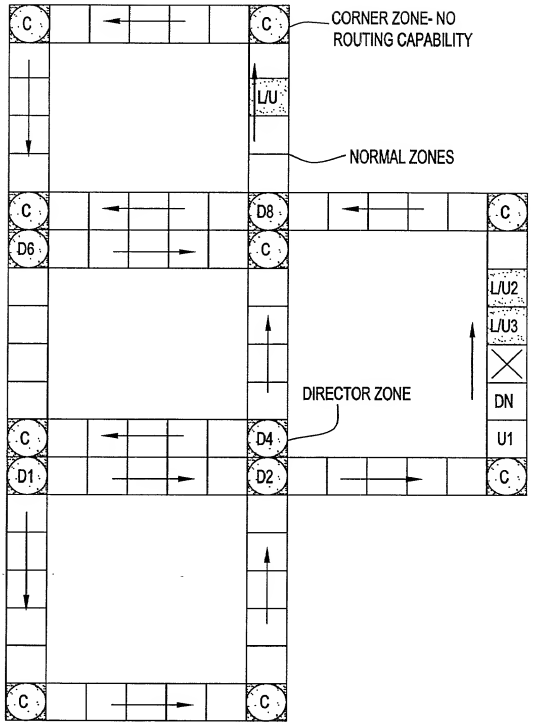

FIG. 37

FAILED DIRECTOR:
EXAMPLE LAYOUT:

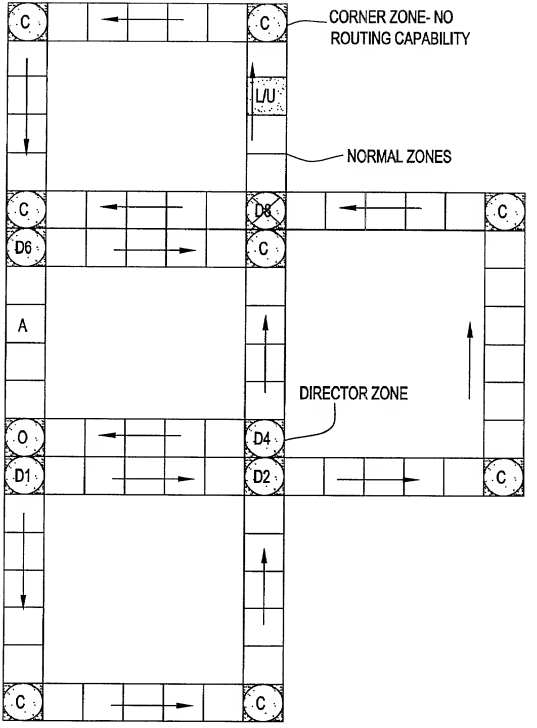

FIG. 38